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ABSTRACT

This paper presents the results of research from Project REALISTIC, a program of research to determine REAding, LIStening and arithmeTIC requirements for jobs; and the feasibility of substituting listening for reading as a means for instructing men of different mental aptitude levels as measured by the Armed Forces Qualification Test (AFQT). Two experiments studied the effects of speech rate upon the comprehension of listening materials by high and low aptitude men. Experiment 1 indicated that low aptitude men appeared to learn easy material better than difficult material as a function of decreased speech rate. High aptitude men appeared to learn materials best at around 175 words per minute, independent of difficulty. In experiment 2, high aptitude men were found to lose disproportionately more material of low association strength than low aptitude men when the speech rate was increased from 175 to 325 words per minute. (Author/PT)

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Two Experiments studied the effects of speech rate upon the comprehension of listening materials by high and low aptitude men. Experiment 1 indicated that low aptitude men appeared to learn easy material better than difficult material as a function of decreased speech rate. High aptitude men appeared to learn material best at around 175 wpm, independent of difficulty. In Experiment 2, high aptitude men were found to loose disproportionately more material of low association strength than did low aptitude men when the speech rate was increased from 175 to 325 wpm.

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This paper presents results of research from Project REALISTIC, a program of research to determine REading, LIstening and ArithmeTIC requirements of jobs. A portion of this program is concerned with determining the feasibility of substituting listening for reading as a means for instructing men of different mental aptitude levels (as measured by the Armed Forces Qualification Test, AFQT).

A drawback to listening for instructional purposes is that, typically, the listener's listening rate is determined by the speaker's speaking rate. However, recent developments (reviewed in Foulke & Sticht, 1969) have provided equipment which permits a wide range of variation in the speech rate of tape recorded messages during playback, without otherwise changing the speech quality.

Previous research (Sticht, 1968; 1969a) has indicated that increasing the speech rate of listening selections above 250-300 words per minute (wpm) reduces the comprehensibility of the message for both high and low aptitude men. Furthermore, this appears to be the direct result of increasing the speech rate, and not the result of any signal distortion introduced by the rate changing process (Sticht, 1969b; Foulke, 1968).

In the present paper, Experiment 1 reports research which extends previous observations by evaluating the combined effects of speech rate and difficulty level of the materials on the listening comprehension of high and low aptitude men.

In Experiment 2, we use the speech acceleration process and a specially constructed test passage to focus on the nature of the differences in the information being picked-up by high and low aptitude men during listening. What we want to know is whether the high aptitude men listening at accelerated rates process the same or different information as the low aptitude men who listen at "normal" speech rates.

Experiment 1

Method

Design. The experimental design was a mixed 2 X 3 X 5 factorial with two aptitude groups, three levels of message difficulty, and five rates of speech. Within-Ss measures were obtained for the three difficulty levels of materials.

Subjects. The Ss were 204 Army inductees. One-half of the Ss were men with AFQT scores at the 30th percentile or below (low mental aptitude, LMA) while the remaining half were men with AFQT scores at the 80th percentile or above (high mental aptitude, HMA). The Ss were assigned to the experimental conditions in an unsystematic manner as they became available until an N of seventeen per condition was obtained. Within an aptitude category, Ss across all conditions were comparable with regard to education, AFQT, and age. All Ss were caucasians.

Material

The materials used were selections seven and fifteen (low difficulty), twenty-three and thirty-one (medium difficulty), and twenty-six and thirty (high difficulty) from the thirty-four passages scaled for difficulty by Miller & Coleman (1967) using Cloze procedures. In addition, the passages were scaled for the present work by means of a modified version of the Flesch readability formula (Farr, Jenkins, Paterson, 1951) and direct magnitude estimation. Details of these scaling procedures are presented elsewhere (Sticht, 1970).

For the present study, the six passages were grouped as indicated into three levels of difficulty: low, medium, and high. The readability scores, in school grade equivalents, for the six passages were: 6.0 and 5.0, 8.5 and 8.5, and 14.5 and 14.5. The estimated magnitude of difficulty scores were: 4.5 and 4.5, 8.0 and 8.0, and 12.0 and 11.5. The Cloze test scores were: 67.2 and 63.0, 47.8 and 46.2, and 35.0 and 33.0. Thus, by all three indices, the materials were of low, medium, and high difficulty.

The passages were prepared for this study by having them recorded in the order given above on magnetic tape at 200 wpm. Then, using the Eltro Information Rate Changer³, the tapes were expanded by fifty-eight, thirty-four and sixteen percent to produce speech rates of 125, 150, and 175 wpm. Two additional versions were prepared by compression at forty-three and forty-seven percent to produce speech rates of 350 and 375 wpm.

For each passage, a Cloze test was formed by deleting every fifth word and substituting a standard six-stroke line. Since each passage

was 150 words long, deleting every fifth word produced a comprehension test of thirty items per passage (an oversight reduced this to twenty-nine items for the first passage in the low difficulty groups). The Cloze tests were grouped into booklets, and separate answer sheets were provided on which Ss could write their responses.

Procedure

The Ss were tested in two sound-deadened testing rooms. Each room contained ten listening cubicles, each provided with earphones and gain control so that each S could adjust the selections to a comfortable listening level to suit himself. Prior to listening to the experimental selections, Ss listened to a warm-up passage of approximately one minute duration.

After the warm-up passage, the stimulus passages were presented, with the order of presentation always being the same — the easy passages were presented first, then the medium, and finally the most difficult passages. After each selection, the corresponding Cloze test was administered. The Cloze tests were scored by counting as correct only those items for which the response was the exact word that had been deleted. Misspellings were counted as correct. Synonyms were not counted as correct. The entire listening and testing procedure lasted an hour.

The Ss in both aptitude categories served in one of six conditions: baseline groups, in which the Ss took the tests without listening to the passages, and five experimental groups, who listened to the speech materials presented at either 125, 150, 175, 325, or 350 wpm and then took the tests.

RESULTS

For all treatment groups, the number correct scores for the two easy selections were combined, as were the scores for the two moderately difficult, and two difficult passages. These raw scores were converted to percent correct scores for presentation in Figure 1. In this figure, the dotted lines mark the baseline scores on the ordinate. Results of the analysis of variance on the number correct scores for the five experimental treatments are given in Table 1. In view of the significant triple interaction of aptitude, speech rate, and message difficulty level, subanalyses were performed on the data for HMA and LMA groups separately. These analyses indicated that, for HMA Ss, there was no significant materials X speech rate interaction, while for the LMA Ss this interaction was significant ($p < .001$).

Examination of Figure 1, and the results of the ANOVA, indicate that the HMA Ss gained about as much when listening to the more difficult materials as when listening to the easier materials, and this was apparently true for each rate of speech. On the other hand, LMA Ss appear to have learned more, the easier the materials and the slower the speech rate.

Insert Figure 1 about here

DISCUSSION

The present results differ from those of Fairbanks, Guttman & Miron (1957) working with Air Force personnel. They found no triple interaction

of aptitude, speech rate, and message difficulty. However, as they pointed out, their aptitude range was fairly limited (stanines 5 to 8). Also, they defined message difficulty in a post hoc manner by studying the item difficulty of their test and reasoning that the more difficult items corresponded to more difficult material. This, of course, totally confounds test item difficulty and message content difficulty. In the present study, message difficulty was determined before the research by three different scaling methods - Cloze tests, a readability formula, and direct magnitude estimations. Hence, it is clear that the messages were of different difficulty. Also the range of message difficulty may actually have been greater in the present work. This seems likely in view of the fact that the material used by Fairbanks, et al. was a technical passage on meteorology, and they presented no materials comparable to the simple 5th or 8th grade material of the present study.

A feature of note in the present data is the indication that the HMA Ss may have performed better at 175 wpm than at 150 or 125 wpm. Indeed, a test for trends indicated a significant quadratic component ($p < .05$) for the HMA Ss (combining the three material difficulty levels). This suggests an optimal speech rate for learning, and, in comparison with the curves for the LMA Ss in Figure 1, this speech rate may be somewhat faster for the HMA than for the LMA Ss.

While the foregoing clearly urges replication, the notion that HMA Ss may learn materials presented at a faster rate than LMA Ss is not new nor startling. In fact, recent research by Shuell & Keppel (1970) utilized a differential presentation rate of information to equate

learning in HMA and LMA Ss. They found that HMA Ss learned a list of thirty words presented at a rate of sixty wpm as well as LMA Ss learned the list when presented at twelve wpm.

In work using accelerated speech (Sticht, 1968) it has also been found that, at certain rapid rates of speech, HMA Ss learn about as much of a listening selection as do LMA Ss listening at normal rates of speech. Thus, as in the Shuell and Keppel paradigm, the use of the speech compression technique permits the arrangement of conditions so that HMA and LMA Ss learn the same amount from a listening selection. When this is done, of course, what is produced is a loss of comprehension for the HMA Ss from what they learn at normal rates of speech.

It has been hypothesized (Foulke & Sticht, 1969) and supported (Sticht, 1969b) that the reduction in comprehension with fast rates of speech occurs because the listener is unable to process information at a rapid rate for storage and subsequent retrieval from memory. This raises the question as to what type of information is lost at the faster rates of speech. Are portions of the passage which demand more processing sacrificed and effort focused more on the easier to process segments? Or do Ss busy themselves with one segment and miss the next regardless of its demand for processing? Various strategies such as these (filtering and omission) have been identified (Miller, 1963) as ways for dealing with overloaded information channels.

In Experiment 2, an attempt was made to determine what kind of information is lost under conditions of rapid speech. The purpose was twofold. On the one hand we were interested in the kind of information lost at faster rates of speech by HMA and LMA Ss. On the other, we

were interested in how the HMA and LMA Ss differed in regard to their processing of information obtained by listening. We know that LMA Ss do not learn as much as HMA Ss when listening at various rates of speech. It is because they process information in a different, less effective way than HMA men, or do they process information in the same way, but just less of it?

Experiment 2

As a first effort in exploring the effects of speech rate and aptitude level of information processing of listening materials, an approach suggested by the work of Rosenberg (1967) was utilized. His research has indicated that association strength between words affects how well they are learned in a prose selection. Word pairs of high association strength tend to be recalled as pairs, while word pairs of low association strength are learned as separate items. It is as though the high association pairs are learned in "chunks" (Miller, G. A., 1956) rather than as separate items of information.

In Experiment 1 it was learned that, across speech rates, the HMA Ss learned easy and difficult materials about equally well. The LMA Ss, on the other hand, learned the easier materials best at the "normal" range of speech rates, while they barely learned the difficult materials at all. The learning of high and low association word pairs can be cast in the same "easy - difficulty" paradigm as Experiment 1. The high association pairs can be considered as "easy" material, while the low association pairs can be viewed as "difficult" material.

Viewed from the foregoing perspective, Experiment 2 can be considered as a partial replication of Experiment 1. Materials having easy to learn, high association word pairs, and difficult to learn, low association word pairs were constructed. These materials were then presented to HMA and LMA Ss and the results of recall tests were examined to suggest how the high and low association materials were dealt with by the two aptitude groups for different speech rate conditions.

Method

Design. A 2 X 2 X 2 repeated measures analysis of variance design was used with two aptitude levels, two rates of speech, and two values of association strength. Within Ss measures were obtained for the two levels of association strength.

Subjects. One hundred thirty-eight Caucasian Army inductees served as Ss. Seventy-two Ss had AFQT scores of eighty or above and formed a high mental aptitude (HMA) group. The remaining sixty-six Ss had AFQT scores of thirty or below and formed a low mental aptitude (LMA) group. Both HMA and LMA groups were trichotomized into three sub-groups, each containing twenty-four and twenty-two men within the respective aptitude levels.

Materials. A 350 word listening passage was prepared which contained triplets of nouns embedded within sentences of the connected discourse. Within each triplet of words, there was a stimulus word

(S-word) and two response words (R_1 and R_2) which varied according to their interword normative association strengths and proximity to the S-word. R_1 was a high association response (HAR) to the S-word while R_2 was a low association response (LAR) to the S-word. The association strengths were obtained from the new Minnesota Norms of Palermo and Jenkins (1964). Within the context of the passage, the S-word, HARs, and LARs always occurred in the same sentence for a given word triplet with the S-word preceding both the HARs and LARs and the HAR preceding the LAR. Thus, the LARs were "difficult" materials on the basis of both association and temporal proximity to the S-word.

The response words were grammatically appropriate in the context of the discourse and each pair was of the same form-class. As a concrete example of the materials, one sentence was: "Inside, the room smelled of tobacco, smoke, and oil." In this sentence, tobacco is the S-word, smoke the HAR and oil the LAR. A total of eighteen such word triplets were embedded in sentences throughout the passage. The grade level of difficulty of the passage was 7.0, as determined by the method of Farr, Jenkins, and Paterson (1951).

The passage was originally recorded at a speed of 200 words per minute (wmp). It then was expanded nineteen percent and compressed thirty-eight percent to give two passages, one at a normal listening rate of 170 wpm and the other at 325 wpm, respectively.

To test for recall of HARs and LARs, a Cloze test was administered. In the Cloze test, the response words were deleted from the passage

and Ss were instructed to fill in the blanks with the correct words. HARs and LARs were counted as correct if they occurred in either of the two response blanks corresponding to the correct S-word.

Procedure

One of the three groups from each aptitude level served as a control group. These two groups were administered the Cloze test without listening to any material. They were instructed to fill-in-the-blank with a word they thought might fit. The group responses under this condition served as baseline data.

The other two groups within an aptitude level were administered the learning passage under one of two listening conditions, at a normal rate of speech (170 wpm) or at the accelerated rate (325 wpm). Ss were instructed that they would hear a listening selection and that they were to try to learn as much of the passage as possible, as they would be tested when the passage was over. Under the compressed speech condition, Ss first listened to a brief warmup passage to permit them to adjust to listening to a fast rate of speech. Following this they listened to the experimental passage. Immediately after hearing the test passage, Ss completed the Cloze test.

Mixed aptitude levels were tested during the same session in groups of approximately thirty men per day. Ss were tested in a classroom and were seated at the front of the room with the tape recorder used to present the listening passage facing them. The volume on the tape recorder was adjusted until all men indicated they could hear it comfortably.

RESULTS

Means and standard deviations for the number of HARs and LARs obtained under each of the speech rate conditions and for each aptitude group are given in Table 2. The total number of correct responses possible under each condition was eighteen. Of note in Table 2 are the nearly identical baseline scores of the two aptitude groups for both HAR and LAR pairs. Evidently the listening materials were constructed so that the superior verbal ability of the HMA groups did not facilitate guessing of correct responses. Of the total number of responses guessed correctly on the baseline tests, ninety-two percent were HAR responses.

Insert Figure 2 about here

Figure 2 presents mean scores transformed to percent correct scores. In this figure, the broken lines mark the baseline scores on the ordinate. A summary of the ANOVA for the aptitude by association level by speech rate design is presented in Table 3. As indicated, one significant first order interaction was obtained. In combination with Figure 2, the significant speech rate by association level interaction indicates that under compressed speech conditions, the mean number of correct LARs decreased to a greater extent than HARs. Also, it is clear from Figure 2 that the greater decrease in LARs is due primarily to the greater decrement in LAR scores for the HMA group under the rapid speech condition. This interpretation is supported by the triple interaction significant at the $p < .10$ level. As expected, the main effects were all significant.

DISCUSSION

The data of Figure 2 indicate that, under both the normal and compressed speech conditions, both aptitude groups processed both HAR and LAR word pairs. While the trend toward a significant triple interaction gave some indication that the decrease in LAR scores under the rapid speech condition for the HMA group was greater than for the LMA group, this difference in terms of percentage of LAR pairs correct with respect to total correct scores was slight. Under the normal speech condition, the total correct scores for the HMA and LMA groups were made up of about the same percentage of LAR pairs, 44.6 and 40.1 respectively. Under the rapid speech condition, the percentages of LAR pairs for the two aptitude groups were even closer, 28.2 and 27.1, respectively. This suggests that both groups sampled the message in a similar manner under both speech conditions, but the HMA Ss processed more LAR pairs at the normal speech rate.

An alternative to these findings would be to observe that Ss largely ignore the difficult word pairs, and approach nearly perfect performance on the easier word pairs. This strategy would involve "filtering" the difficult pairs. It seems likely that such filtering would more readily be observed under reading rather than listening conditions. This is because the persisting, spatial display of the printed page would permit rapid scanning and early determination that some materials would be easier to learn than others. In listening, however, there is a nonpersisting, temporally linear "display" which does not permit an early discrimination of easy from difficult materials. Under these conditions, it is reasonable that information

processing would tend to follow the message, and hence all segments would be sampled indiscriminately. However, more difficult materials would be less likely learned as the forced pace of the listening material caused Ss to drop the encoding of one information unit and proceed to the next (or to ignore the next unit while dealing with the preceeding unit).

A second observation in Experiment 2 concerns the slight differential effect mentioned above, of increasing the speech rate on the learning of HAR and LAR word pairs by the two aptitude groups. Although the HMA group learned more LAR word pairs than the LMA group at the normal speech rate, they learned almost the same number of LAR word pairs at the faster speech rate. Thus the pressure induced by the acceleration of speech took a greater toll on the ability of the HMA people to learn the more difficult associations. This is consistent with Rosenberg's (1967) suggestion that HARs embedded in prose facilitates storage of information because they are recalled as pairs, while the LAR word pairs are learned more as individual units. Hence, if the time per unit for learning is reduced, this will have a greater effect upon the learning of LARs than HARs. In the present study, the greater decrease in mean number of LAR word pairs recalled correctly by the HMA Ss under the compressed speech condition indicates that they were not being processed as efficiently as the HAR word pairs.

The present study and Experiment 1 point out the usefulness of speech compression in investigations of individual differences in the processing of information presented through listening materials.

By adjusting the compression ratio for a given set of learning materials, the performance of high aptitude Ss can be manipulated until it is approximately equal to the performance of low aptitude Ss who have listened to the materials at a normal rate of speech. Once the performances for different aptitude groups have been equated, differences and/or similarities in type or kind of information transmitted can be investigated. This may lead to clues about individual differences in storage/retrieval strategies.

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Table 1

Analysis of variance for the data of Experiment 1.

Source	df	Mean Square	F
Between Subjects	169		
Aptitude (A)	1	34,555.30	287.39*
Speech Rate (B)	4	925.95	7.71*
A X B	4	103.80	
Error	160	120.24	
Within Subjects	340		
Difficulty (C)	2	16,366.41	922.57*
A X C	2	136.81	7.71*
B X C	8	50.24	2.83*
A X B X C	8	56.88	3.21*
Error	320	17.74	

* $p < .005$

Table 2

Means and Standard Deviations of HA and LA
Responses for Each Aptitude X Listening
Condition

Mental Aptitude		LISTENING CONDITION					
		Baseline (0 wpm)		Compressed (375 wpm)		Normal (170 wpm)	
		HAR	LAR	HAR	LAR	HAR	LAR
HMA	MEAN	6.79	.54	9.96	3.92	13.33	10.71
	S.D.	1.98	.59	2.18	1.86	2.63	3.93
LMA	MEAN	7.14	.68	7.45	2.77	10.73	7.18
	S.D.	1.78	.71	2.11	2.18	3.69	3.45

Table 3
Analysis of Variance for Experiment 2

Source	df	Mean Square	F
Between Subjects	91		
Aptitude (A)	1	291.20	28.80*
Speech Rate (B)	1	958.70	94.83*
A X B	1	22.02	2.18
Error	88	10.11	
Within Subjects	92		
Association (C)	1	852.26	209.40*
A X C	1	1.44	—
B X C	1	54.35	13.35*
A X B X C	1	11.43	2.81 ^a
Error	88	4.07	

* $p < .001$ ^a $p < .10$

Footnotes

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Figure Captions

Figure 1. Recall test scores for high and low mental aptitude Ss for materials of three difficulty levels presented at five rates of speech. The dotted lines mark baseline scores on the ordinate.

Figure 2. Recall test scores for high and low mental aptitude Ss for a passage containing word pairs of high and low association strength and presented at two rates of speech. The dotted lines mark baseline scores on the ordinate.

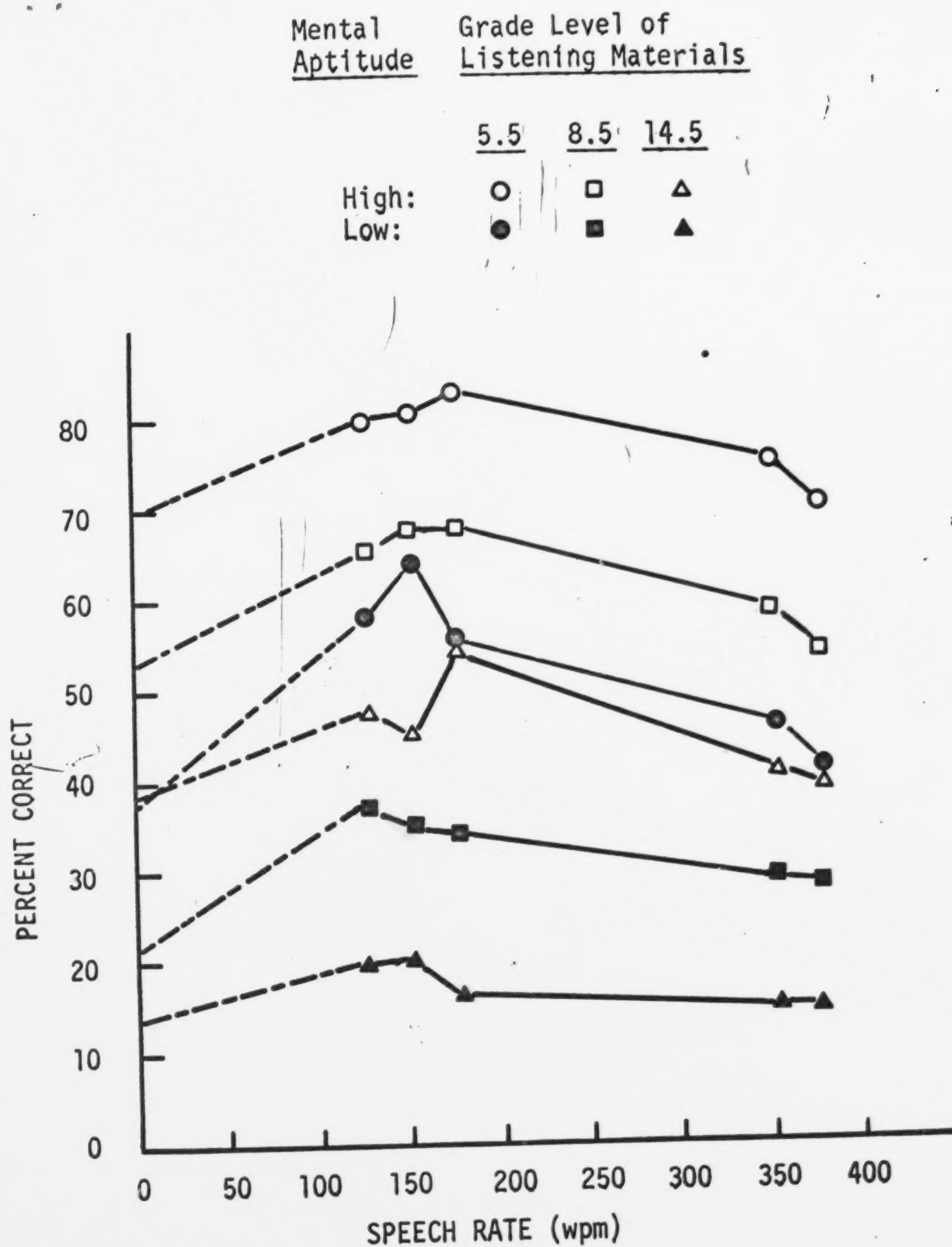
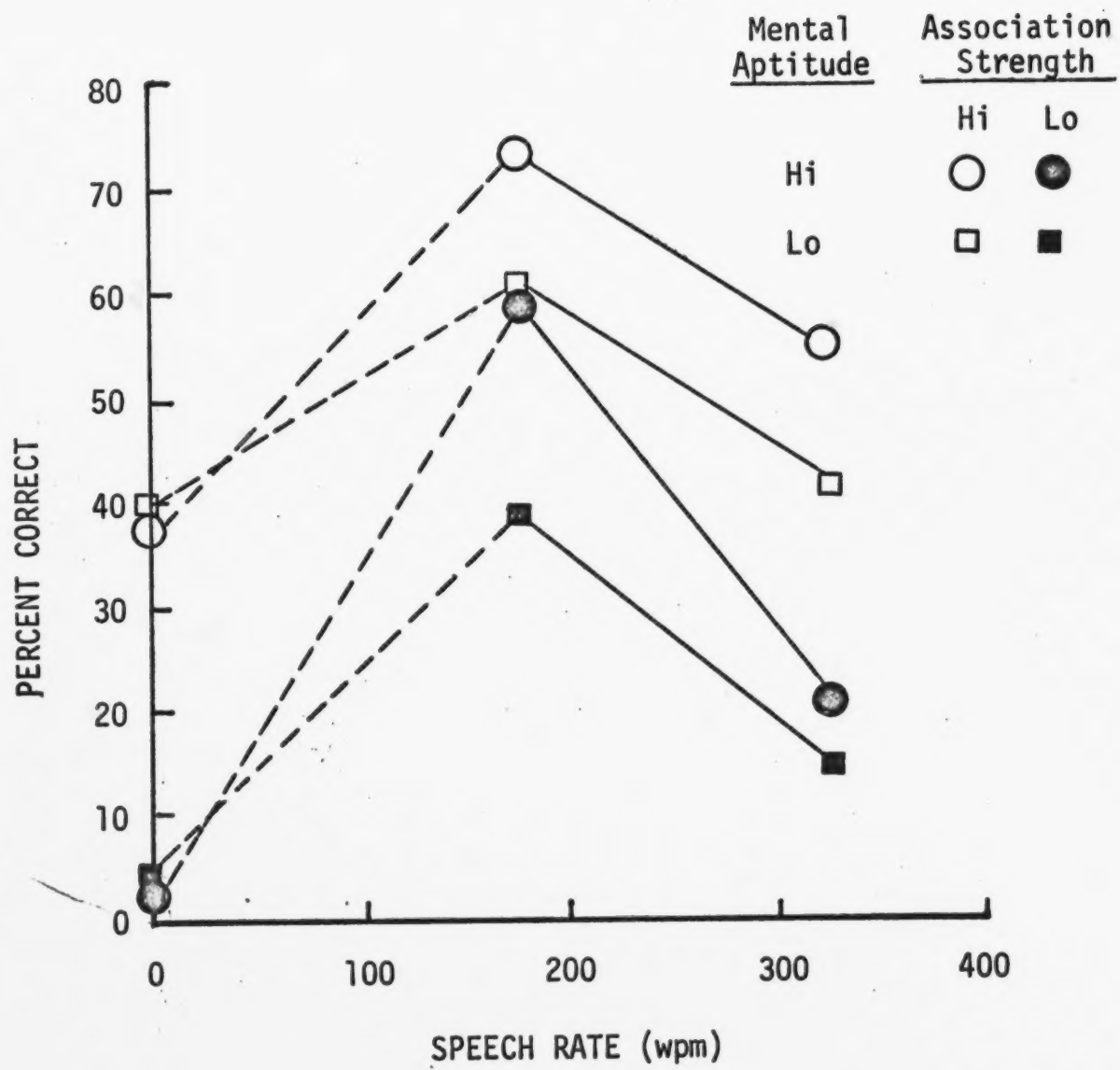


Figure 1



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